Utah Copper Company

METALLURGICAL DEPARTMENT

GARFIELD

UTAH

H I S T O R Y O F

A R T H U R P L A N T

M A G N A P L A N T

AND

L E A C H I N G P L A N T

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October 24th, 1923.

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UTAH COPPER COMPANY

METALLURGICAL DEPARTMENT

HISTORY OF THE ARTHUR CONCENTRATING PLANT

The Arthur Plant, originally known as the Boston Consolidated Mill, is located on a tract of approximately 900 acres of land, situated about midway between the Bingham Plant and Garfield townsite. Construction of the Boston Consolidated Mill started during May 1906 and was completed during July 1909. When finally put in operation the Mill consisted of 10 units having a total milling capacity of approximately 3,000 tons per 24 hours.

On February first, 1910, the Boston Consolidated was absorbed by the Utah Copper Company who immediately set to work forming plans for the installation of new apparatus necessary to the promotion of greater capacity. These plans developed into actual remodelling, which started during August 1910, and was completed during the same month of 1912.

A discussion of the various changes in equipment and methods during the life of the Arthur Plant is confined to five separate departments, together with a chapter of miscellaneous items, as follows:

Course Crushing Department
Fine Crushing Department
Gravity Concentration Department
Flotation Concentration Department
Dewatering of Concentrate Department
Miscellaneous

COARSE CRUSHING DEPARTMENT

Under the control of the Boston Consolidated this department consisted of a steel bin having a capacity of approximately 10,000 tons, into which the mine-run of ore was dumped from bottom dump cars. From this bin the ore was fed to a conveyor by means of apron feeders, thence to two No. 5 and two No. 6 Gates Gyratory crushers. This constituted the entire course crushing equipment.

The Utah Copper Company made no change in the size of the storage bin, but they did install two sets of grizzlies of various openings to separate the course and fine material. The first set of grizzlies were used only for catching rocks greater than 12 inches in size, these being reduced to proper size by sledge hammers. While the second set directed the proper size

ial to pan conveyors and fine material to belt conveyors, thence to crushing machinery.

Two over-lapping 3 and 4 steel pan conveyors were installed to carry the coarse ore from storage bins to crushers, and two 42 inch belt conveyors were placed to handle the finer material. In both cases the ore was fed to these conveyors by means of steel apron feeders which by the way were the only machines in this department that were not discarded by the present company.

Two sets of 72"x20" Garfield rolls and one 36 inch elevator were added during August 1911, for the purpose of handling oversize from the Gates gyratory crushers. In June 1912 the Gates gyratory crushers were replaced with two No. 8 McCully gyratories; one additional 36 inch elevator and two additional sets of 72"x20" Garfield rolls, put in operation during the same month. A third McCully crusher was installed during June 1913, and a building to house this machinery was also completed in June 1913.

With the additional equipment as outlined the coarse crushing capacity was increased from approximately 3,000 to 16,000 tons per 24 hours, the same being reduced from 12 inch to 1 inch in size. No further changes of any importance were made in this department until 1919.

During January 1919 what is known as the primary coarse crushing plant was put in operation. New equipment at this time consisted of a Heulett car dumper capable of automatically dumping approximately 440 cars of ore per 24 hours. This installation was made primarily to increase plant capacity during winter and early spring months, as the condition of the ore at such time made the dumping of same by hand a very slow process. Necessary grizzlies were installed to take out the plus 6-1/2 inch rocks which were sent to a No. 27 Allis-Chalmers gyratory crusher having a capacity for sizes up to 54 inch and a reduction to 6-1/2 inch. Bins, feeders and conveyors were placed to deliver the ore from this department to what is now known as the secondary coarse crushing department.

Changes at this time in the secondary coarse crushing plant consisted of the removal of one 36 inch elevator which was replaced by a system of conveyor belts. An extra set of 72"x20" Garfield rolls were installed together with 8 Mitchell vibratory screens, the latter replacing stationary screens heretofore employed. These changes in equipment were made not only to increase tonnage capacity, but also to make a greater reduction of the product delivered to the fine crushing department.

Adequate over-head crane facilities and additional rigger shed capacity were also provided for handling repairs to all coarse crushing equipment.

During March 1921, four Mitchell vibratory screens were installed underneath the coarse ore bins, for the purpose of handling the undersize from 1-1/4 inch grizzlies. The undersize from these screens was sent direct to fine crushing plant, thus eliminating a portion of tonnage which was previously delivered to 72"x20" Garfield rolls. With the completion of these latter changes this department is now capable of handling approximately 20,000 tons per 24 hours.

FINE CRUSHING DEPARTMENT

Under the ownership of the Boston Consolidated this department consisted of one steel ore bin having a capacity of approximately 13,000 tons, from which the ore was fed to Nisson Stamps by means of Challenge feeders. Twenty-four of these stamps constituted a unit, the capacity of same being rated at 10-5 tons per each 24 hours or a total of 3,276 tons per day for 13 units provided no lost time was recorded.

The Utah Copper Company began hanging up these stamps in October 1910 and started replacing same with two 37-1/2"x15" Garfield rolls per unit for preliminary grinding and two 6 foot Chilean Mills per unit for regrinding. Apron feeders were placed to deliver feed from storage bin to rolls and six 3'x4' Impact screens per unit were installed to obtain the required sizing. One 24 inch elevator per unit was also installed to handle Impact screen oversize which was a circulating feed to rolls. Of the 6 Impact screens in operation, two were used at the fine bin feeders and the remaining four were placed as return screens to handle product from 24 inch elevator. The placing of this new equipment was completed during August 1912.

During the winter of 1916-1917 each unit was arranged so that water could be added to the feed delivered to both feeder and return Impact screens. This was done to eliminate, as much as possible, the trouble experienced with wet and sticky ore during cold weather, the same having a tendency to blind screens, clog rolls and launders thus greatly reducing milling capacity.

During the early part of 1917 all feeders used for delivering ore from storage bin to 37-1/2"x15" Rolls were increased in width from 30 inches to 60 inches. This was done to obtain a more steady flow of ore as the narrower opening associated with the 30 inch feeder caused the ore to pack around the feeder in the fine bins. The change has proven very satisfactory.

When it became necessary during the war to increase production beyond limits hereto fore maintained considerable trouble developed on account of excessive over-load on all 200 H.P. motors used to drive rolls, Chilean mills and Impact screens. Consequently in January 1918 the work of replacing these motors with 300 H.P. motors was started and completed during May of the same year. At this time the 200 H.P. motors on units 12 and 13

were not changed as 3 Marcy ball mills had replaced 3 rolls on these two units, the former machine being equipped with individual motors.

During February 1921 work was started which involved removing all feeder Impact screens and installing them in the same position as that occupied by the 4 return Impact screens previously described, thus permitting the ore to be delivered direct from fine bin to 24 inch elevators, thereby obtaining greater screen efficiency without increasing the screening area. This change was completed during March 1921.

For the purpose of carrying on experimental work in connection with the flotation concentration of Mill Slime, two No. 86 Marcy ball mills were installed to take the place of 37-1/2"x15" Garfield rolls on Unit 13. The first of these mills was put in operation during May 1915 and the second during the following October. A third Marcy was also installed on unit 12 during August 1915, the same replacing one 37-1/2"x15" Garfield Roll. The Marcy mill is a wet grinding machine having the discharge end fitted with a fine grate covering practically its entire surface. The feed enters the mill through the trunion and is reduced to fineness by means of steel balls.

These mills eliminated the use of Impact screens and the 24 inch elevator otherwise required for handling the circulating load to rolls. During early experimenting with these machines it was found that when handling fine bin feed exclusively (maximum size 3/4 to 1 inch), the necessary fineness of product could not be obtained without greatly reducing tonnage. To remedy this condition a drag classifier was installed for each mill to which a portion of the first spigot of primary hydraulic classifiers was delivered, the drags serving as a dewatering machine, discharging their sand product as a circulating load to the ball mills. With this arrangement greater capacity was maintained

The Marcy Mill on Unit 12 was discarded during June 1920 and replaced the following month with a 54"x20" Roll. Both Marcy Mills on unit 13 were discarded during December 1920, and replaced with two 37-1/2"x15" Garfield Rolls the following month. A 30 inch elevator was also installed on this unit to replace the 24 inch elevator which was in use prior to the placing of the Marcy mills. Mitchell vibratory screens were used in place of Impacts, but were finally replaced by Impacts during May 1922. The Mitchell screen did not prove satisfactory in this service. During November 1920 the 54"x20" Roll on Unit 12 was also replaced with a 37-1/2"x15" Garfield Roll.

During the middle part of 1916 work was started on a new slime flotation plant to be used in the treatment of mill slime by the flotation process which from experimenting proved that greater efficiency could be obtained from treating the

finer material than was possible to obtain by gravity concentration of either coarse or fine material. Thus it became necessary to increase the crushing efficiency of this department by the addition of equipment capable of producing economically, a maximum amount of slime feed suitable for flotation. The grade of this feed being a minimum percentage plus 65 mesh Tyler Standard Screen.

After investigating data covering the various kind of machines in this service at other plants, a 7'x10' tube mill of the Power and Mining Co. type was selected. Twenty-six of these mills or 2 tube mills per unit were put in operation during a period from March 1917 to February 1918 inclusive. The following tabulation shows when each individual mill was released for service:

Unit No.	Tube Mill Number	Date Put In Service	Tube Mill Number	Date Put In Service
1	1	May 20, 1917	2	May 5, 1917
2	1	Apr 12, 1917	2	Apr 10, 1917
3	1	Mar 21, 1917	2	Mar 21, 1917
4	1	Oct 11, 1917	2	Oct 12, 1917
5	1	Oct 31, 1917	2	Oct 31, 1917
6	1	Nov 26, 1917	2	Nov 26, 1917
7	1	Dec 17, 1917	2	Jan 6, 1918
8	1	Jan 7, 1918	2	Jan 7, 1918
9	1	Jan 7, 1918	2	Jan 7, 1918
10	1	Jan 22, 1918	2	Feb 1, 1918
11	1	Feb 1, 1918	2	Feb 1, 1918
12	1	Feb 2, 1918	2	Feb 2, 1918
13	1	Feb 2, 1918	2	Feb 22, 1918

To feed these mills with material having a proper consistency, one 7'x9' drag classifier similar to the Dorr type was installed at the head of each tube mill. These drags dewatered a classified product from hydraulic classifiers delivering a coarser product to tube mills and overflow or fines to Dorr thickeners for flotation treatment. Four 6 inch centrifugal sand pumps were put in operation to handle this overflow as required.

With the installation of the foregoing grinding machinery the efficiency of this department was increased to a considerable extent and as a consequence the basis of normal mill tonnage was advanced during March 1918 from 7,000 to 16,000 tons per 24 hours.

As originally installed, 22 tube mills were charged with pebbles and were driven with 75 H.P. motors while the remaining 4 operating on Units 2 and 3 were charged with balls

which required motors having 150 H.P. capacity. These mills were operated in this manner from the time they started until August 1919 when the work of changing from pebbles to balls commenced. This work involved equipping such mills as were changed, with 200 H.P. motors as the 150 H.P. type originally used with ball grinding mills were considerably overloaded at times and caused some trouble. Equipment of 22 mills with 200 H.P. motors and changing grinding medea from pebbles to balls was carried out according to the following schedule:

2	Tube Mills	changed	August 1919
4	"	"	October 1919
8	"	"	November 1919
1	"	"	December 1920
3	"	"	October 1922
4	"	"	March 1923

In the foregoing paragraph it was pointed out that the original installation consisted of 2 tube mills per unit, but various units were later equipped with a third tube mill, the same being put in operation according to the following schedule:

Unit 4	December 1919
Unit 3	January 1920
Unit 11	November 1922
Unit 8	May 1923
Unit 9	September 1923

The same type of drag classifier as originally installed was also placed for accomodating each of these additional tube mills.

The use of certain Chilean Mills was discontinued during 1922 and 1923. Altho they were not removed from their original location in the fine crushing department. The following tabulation shows the identity and time of shutting down these mills:

Unit 12	2 Mills	July 1922
Unit 3	2 Mills	October 1922
Unit 11	2 Mills	February 1923
Unit 4	2 Mills	February 1923
Unit 9	2 Mills	September 1923

Necessary crane facilities were added and additional rigger equipment provided for maintaining repairs. It was also necessary to makeextensive changes in mill handling to accomodate these tube mills and apparatus necessary to their up keep.

The following comparison of average daily tonnage treated from 1910 to September 30th 1923, inclusive, will give some idea of the advantage gained through changes made in coarse and fine crushing equipment during the period mentioned:

Year	Tonnage Treated Per Month	Per Day
1910	85173	2805
1911	79616	2615
1912	155043	5083
1913	281391	9251
1914	258221	9293
1915	293618	9670
1916	404208	13253
1917	455400	14972
1918	461308	15166
1919	431092	14200
1920	463067	15183
1921	406900	13716
1922	455031	15367
1923 (1st 9 months)	532088	17541

The entire plant was down from August 7th 1914 to January 25th 1915 on account of the European War. A decided curtailment of copper occured 1919 and 1920 which finally resulted in again shutting down the entire plant from April 4th 1921 to April 4th 1922.

GRAVITY CONCENTRATION DEPARTMENT

Under Boston Consolidated ownership the feed to this department was delivered direct from Nissen Stamps to 4 three spigot hydraulic classifiers per mill unit. Spigot product from these classifiers was sent to 22 Wilfley tables per unit; concentrate from tables to bins and tailing to waste. The classifier overflow or slime was delivered to 24 Callow Settling Tanks per unit; underflow from tanks went to 18 Johnston Vanners per unit, the overflow from tanks being pumped back for re-use. The Vanners produced a concentrate for shipment and a tailing to waste.

The remodelling of each mill unit as inaugerated by the Utah Copper Company consisted of installing 24 Garfield roughing tables to which the undersize from impact screens was delivered direct. The Garfield tables mentioned are a modification of the Standard Wilfley type. One 30 inch elevator was placed on each unit to carry tailings from roughing tables to 4 Richards-Janney four spigot hydraulic classifiers, per unit. These latter machines eliminated the three spigot type classifiers used by the Boston Consolidated. One 18 inch elevator, per unit, was installed for delivering concentrate from Garfield rougher tables to one 3 spigot hydraulic classifier per unit.

these classifiers being utilized from Boston Consolidated mill. Two additional Wilfley tables per unit were placed to handle a circulating load from the 3 spigot classifiers but these were abandoned during the latter part of 1917.

Four Richards Janney 5 spigot hydraulic classifiers per unit were installed to handle a product from the 4 spigot machines, the former classifiers discharging spigot products to 24 Ishell Vanners per unit, also installed by the Utah Copper Company. Four additional Ishell Vanners were also placed to treat overflow from 3 spigot classifiers, but these were removed in September 1917. The Utah Copper Company utilized all Callow settling tanks formerly employed by the Boston Consolidated, but installed 4 additional per unit, these machines being used to settle mill slime. Thirty-six Ishell and Johnston Vanners per unit were installed for treating this slime and two 8 inch pumps placed for returning tank overflow from sumps to concentrating machines.

Remodelling and installing the above equipmentstarted during August 1910, the various mill units being completed and put in operation according to the following schedule:

Unit 1 started operating March 1911
Unit 2 started operating April 1911
Unit 3 started operating July 1911
Unit 4 started operating July 1911
Unit 5 started operating August 1911
Unit 6 started operating October 1911
Unit 7 started operating January 1912
Unit 8 started operating February 1912
Unit 9 started operating April 1912
Unit 10 started operating May 1912
Unit 11 started operating June 1912
Unit 12 started operating July 1912
Unit 13 started operating August 1912

At the completion of this installation in August 1910 the mill was treating about 8,000 tons of ore per 24 hours and during the following period prior to later remodelling treated more than three times its original capacity under Boston Consolidated ownership.

The next improvement inaugerated was the installation of a Gravity retreatment plant, the construction of which started in March 1912, and was completed in August 1912. New equipment installed in this plant consisted of two 24 inch elevators, 2 Richards-Janney 5 spigot hydraulic classifiers, two 6 spigot classifiers of the same type, 8 Wilfley tables and 8 Johnston Vanners. The object of this plant was the treatment of Vanner concentrate for the purpose of eliminating all excess silica possible in order that the tonnage of concentrate shipped for smelting might be reduced and thereby obtain a reduction of total smelting cost. This plant was abandoned in August 1920, after

sand vanners were discontinued, and was finally torn out during the spring of 1923.

During the period devoted to the installation of tube mills in the Fine Crushing Department an extensive campaign of remodelling was also inaugerated in the Gravity Concentration Department. This remodelling consisted of changing 18 inch and 30 inch elevators from wood to concrete housings. A concrete floor was built directly above the Garfield Roughing tables on which was placed two Wilfley tables formerly in use, and two additional tables as new equipment. Concrete launders replaced those of wood for carrying table products to main tunnel launder. The main tunnel for carrying various mill products was enlarged and concreted throughout. A concrete floor was also built directly above tube mill drag classifiers, to which the Richards-Janney 5 spigot hydraulic classifiers were moved from their former position back of the 4 spigot machines. A concrete floor and pillars were also installed in that portion of the mill building occupied by vanners treating sands from 5 spigot hydraulic classifiers.

The elimination of Slime Vanners started during March 1917, and continued until May 1918,when they were entirely abandoned, as the slime flotation capacity at the latter date was sufficient for handling this material. During June 1920 two Richards-Janney 4 spigot classifiers were abandoned on each mill unit because a good portion of tonnage formerly handled by Chilean Mills was diverted to tube mills. The use ofSand Vanners was discontinued in August 1920, all of these machines being torn out during 1922. These machines were no longer needed after adopting the practice of regrinding and treating all grovity tailing by flotation.

Unit No. 12 was remodelled to provide drag classifiers as a substitute for Richards-Janney hydraulic classifiers formerly employed, two 4 spigot and four 5 spigot classifiers were abandoned. This change was completed and the unit put in operation during July 1922. During August 1923 the work of installing three 12'x16' drag classifiers on Unit 4 was completed. These drags eliminate the use of two 4 spigot and four 5 spigot hydraulic classifiers and will permit the preparation of slime for flotation without previous dewatering by Dorr thickeners.

FLOTATION CONCENTRATION (Treatment of Vanner Concentrate)

During the early part of 1913 an experimental laboratory was erected at the North end of the mill. This structure consisted of an oil storage room, a room in which to make flotation experiments and a room equipped for the purpose of making chemical analysis of oils submitted for testing. From experiments carried on in this department the laboratory type Janney flotation machine was developed which later resulted in the con-

struction of commercial machines on the same principle.

Experimental work at this time was confined to the development of a flotation process by which low grade vanner concentrate could be treated to eliminate excess silica and by this means secure a reduction in smelting cost. The vanner concentrate contained an average of approximately 50 percent insoluble which not only increased the tonnage shipped for smelting but resulted in a penalty charge besides. A successful method of treating this vanner concentrate was worked out during the early part of 1914.

During July 1914, four Janney Mechanical flotation machines of commercial capacity were installed for the purpose of treating classifier overflow from gravity retreatment plant, (Low grade vanner concentrate) but before operating conditions could be fully adjusted the Arthur Plant shut down on account of war.

The plant resumed operations during January 1915, at which time a flotation machine consisting of two Janney type emulsifiers and 13 single spitz mechanical cells were installed and put in operation. Each emulsifier and flotation cell was driven by individual 10 H.P. Motors. Mechanical froth removers were also attached to each spitz. Other new equipment installed was a cone tank for thickening the feed and a 20 foot sludge tank for delivering the thickened feed to emulsifiers. During June 1915 this 20 foot tank was converted into a thickener but abandoned the following month when two 44 foot Dorr thickeners were added to this plant. In September 1915 this machine was remodelled and converted into a double spitz type to promote greater efficiency and capacity.

On account of an increase in mill capacity a second machine was installed and put in operation during July 1916. This machine consisted of two Janney type emulsifiers, 15 double spitz mechanical cells together with necessary motors and froth removers. The use of this machine for treating vanner concentrate was discontinued in August 1917 because the production of such material had decreased on account of starting a portion of the new slime flotation plant.

The treatment of vanner concentrate by flotation required an alkaline reagent for successful operation and to provide such a reagent a plant was constructed consisting of two 7,500 gallon wood stave tanks and necessary mixing vats.

Flotation concentration of vanner concentrate was discontinued and machines abandoned during April 1919 because the amount of such concentrate became very small and was gradually decreasing about this time. This product after April 1919 and up to August 1920 was mixed with the mill slime and treated in

the Slime Flotation Plant.

FLOTATION CONCENTRATION (Slime)

Experimental machines for treating crude ore and mill slime were constructed and put in operation on unit 13 during May 1915. These machines consisted of 2 rows of flotation cells, each having 2 emulsifiers and 15 mechanical flotation cells. Callow cone tanks and a 20 foot sludge tank were installed for handling the thickened pulp. In August and September 1915, two 75'x12' Dorr thickeners replaced the cone tanks the latter being abandoned.

In February 1916 a pyramid mechanical air machine consisting of 12 emulsifiers and 30 flotation cells was put in operation. A Roots Blower was included in this equipment for supplying low pressure air introduced through a canvas blanket in the spitz. The successful application of flotation in treating slime was worked out on this machine andimmediately steps were taken towards the construction of a plant having sufficient capacity to handle all slime produced from milling operations. The two experimental machines previously mentioned were abandoned during May 1917 after the pyramid machine had proved a success.

Construction work on the new slime flotation plant began the latter part of 1916 and as fast as various units were completed they were put in operation according to the following schedule:-

Unit Number	Type of Machine	Date Started
1	Mechanical - Air Rougher	Feb. 1918
2	" " "	Aug. 1917
3	" " "	Feb. 1917
4	" " "	Feb. 1917
5	" " Cleaner	May 1917
6	Straight - Air Cleaner	May 1918
7	" " Rougher	July 1918
8	Mechanical - Air Rougher	Aug. 1918
9	Straight - Air Rougher	May 1918
10	" " "	May 1918
11	" " "	May 1918

This plant including the building and flotation cells was constructed almost entirely of concrete. Cast iron impellers and cell liners were used together with vitrofied pipe wherever possible. A Rigger shed, pumps, sumps and apparatus for manufacturing air blankets were also installed. A blower house was also included in this equipment, the same containing 12 Roots blowers each having a capacity of 10,000 cubic feet of air per minute at 5 pounds pressure. Six of these blowers were abandoned early in 1923.

The first installation, it will be noted, included some straight air machines, these however, were converted to mechanical air cells during August 1918 because the straight air cells were not as efficient metallurgically as the mechanical - air type

For the purpose of delivering feed of the proper consistency to the flotation plant a series of Dorr thickeners were installed, the same replacing callow cone tanks originally used for settling slimes. These Dorr thickeners were put in operation according to the following schedule:

Tank Number	Size	Date put in Operation
1	75'x12'	Aug. 1917
2	"	Aug. 1915
3	"	Sept. 1915
4	"	Oct. 1916
5	"	Nov. 1916
6	"	Feb. 1917
7	75'x18'	May 1917
8	"	Aug. 1917
9	"	Feb. 1918
10	"	Mar. 1918
11	"	July 1918
12	"	May 1918
13	"	June 1918
14	"	Apr. 1918

With the starting up of Unit No. 4 during August 1923 under a flow sheet by which flotation feed is prepared without Dorr thickener as previously explained, No. 9 Dorr thickener was abandoned.

When construction work started on the Slime flotation plant new ground was purchased and made ready to provide a separate pond for the disposal of flotation tailing. A concentrate launder about 1/2 mile in length was also built and put in operation during April 1918 for the purpose of carrying the waste material from the mill to the new pond. This portion of the pond has since been filled up and the launder is only used occasionally for wetting down tailing dust. Early in 1919 a new launder was constructed to carry flotation tailings directly across the old tailing pond to the North pond. This launder being still in use.

During the early part of 1918 a new laboratory was erected for the purpose of housing equipment used in making various metallurgical tests in connection with mill operations, etc. This building consisted of a chemical room, office, oil storage and flotation test rooms.

In connection with the installation of flotation equipment the following tanks were erected for the purpose of storing oils and reagents necessary to the operation of such process:

Oil Storage

Number of Tanks	Gallons Capacity Per Tank	Gallons Total Capacity
9	37600	338400
4	14400	57600
4	5700	22800
3	440000	1320000
1	47000	47000
Total		1785800

Acid Storage

2	37600	75200
1	5700	5700
Total		80900

During the early part of 1917 a plant was built for the purpose of reconstructing certain oils necessary to flotation treatment. At that time this plant consisted of one 500 gallon still, but three stills of the same type and capacity have been added since. This total equipment was completed about the time that flotation was operating to full capacity

An experimental flotation plant was installed on Unit 12 and 13 during the latter part of 1920. This plant consisted of two Improved Janney Mechanical Air Cells, each having one emulsifier and 13 flotation cells. A Callow pneumatic air machine was also installed on unit 13 during the same time. The Callow machine was shut down in the early part of 1923, but the Janney machines remained in operation and are being used for testing out various oils, reagents, flow sheets, etc.

During the latter part of 1922 the work of replacing cast iron liners with adamant silica blocks, was started. This was not finished until the early part of 1923, the length of time required being due to remodelling only a small portion of the plant at a time, so as not to interfere with capacity. During the early part of 1923 the work of changing cast iron impellers to rubber impellers was completed. Both of these changes were made to decrease the cost of operation by substituting material that would more readily withstand the action

of sulphuric acid used in the process.

DEWATERING OF CONCENTRATE

Under Boston Consolidated ownership this department consisted of 10 concente bins of about 250 tons capacity each from which concentrate was loaded in cars by means of a clam shell. A sump at one end of these bins was used for collecting overflow which was in turn pumped to 1,000,000 gallon reservoir supplying mill water.

The Utah Copper Company built 16 new concrete bins having practically the same capacity and turned the last one over to operation during August 1912 at which time the 10 bins formerly used by the Boston Consolidated were abandoned. An electric crane operating a clam shell bucket was installed, the same replacing clam shell formerly used.

With the introduction of flotation concentration at the Arthur Plant a serious difficulty arose in handling the concentrate produced, in as much as it contained a considerable amount of slime material and more or less oil which rendered it impossible for dewatering with means employed up to this time. Consequently a filtering system was installed for reducing the moisture content to a point suitable for economical handling, both at the mill and Smelter. This plant consisted of Dorr thickeners, elevators, drag classifiers, filter vacuum pumps, reservoirs, conveyors etc. A suitable building to house filters, drags, elevators and vacuum pumps was also erected.

Equipment necessary to this plant was put in operation according to the following schedule:

Dorr Thickeners

No.	Size	Date put in operation
1	75'x18'	Apr. 1917
2	"	Aug. 1916
3	"	Mar. 1917
4	"	Sept. 1918
5	"	Dec. 1917
6	"	Sept. 1917
7	"	July 1917
8	"	Aug. 1917
9	100'x12'	Apr. 1919
10	"	June 1919

Four of the 75 foot by 18 foot thickeners were abandoned by this plant during the latter part of 1922 and early

part of 1923. The removal of this equipment was possible after discontinuing the use of 20 pounds of oil in flotation treatment As heretofore this quantity of oil resulted in a concentrate that was at times very hard to settle.

During May 1923 a 44 foot Dorr thickener was installed and another placed in July following, both of which are used for settling overflow from drag classifiers which was formerly directed to the larger thickeners along with flotation concentrate. These two thickeners were moved from the former flotation retreatment plant which was abandoned during April 1919 as previously mentioned.

With the installation of the first Dorr thickener the placing of 14'x14' Portland filters was also started. When finished the filtering department consisted of 12 Portland and 2 14 foot American filters, these machines having been put in operation according to the following schedule:

Filters

No.	Kind	Date put in Operation
1	Portland	Aug. 1916
2	"	Mar. 1917
3	"	June 1917
4	"	Oct. 1917
5	"	Nov. 1917
6	"	Nov. 1917
7	"	Dec. 1917
8	"	Mar. 1918
9	"	Apr. 1918
10	"	Apr. 1918
11	"	June 1918
12	"	Sept. 1918
1	American	Nov. 1919
2	"	Oct. 1919

In February 1918, four drag classifiers equipped with vacuum at the discharge end were completed and put in operation. These machines were used to reduce the moisture content of Wilfley table concentrate, which after dewatering supplied a thick granular product that was mixed with flotation prior to filtering to gain more filter efficiency.

During August 1919 a concrete reservoir having a capacity of approximately 1,000,000 gallons was added to this department. This installation was made on account of the difficulty of settling the concentrate product resulting from 20 pound oil treatment.

MISCELLANEOUS

Water Supply

Water used in the Boston Consolidated Mill was obtained from Spencer's Springs located a half mile North of mill buildings, the same being delivered by means of Byron-Jackson pumps to a reservoir of 1,000,000 gallons capacity. Water from this spring formed a portion of that used by the Utah Copper Company until August 1914 when the spring became covered up with tailings. A concrete reservoir having 2,000,000 gallons capacity was constructed about 200 yards South-East of the mill building and put in operation during October 1912. Until August 1914, all water in excess of that supplied by Spencer's Springs was pumped from the Magna Plant. The source of the latter plant consisted of springs at the mill and also a supply from Utah Lake which is delivered to Magna by a canal about 40 miles in length. Since August 1914 all water has been pumped from Magna to the Arthur Plant Reservoir.

Sampling and Assaying

Automatic, hydraulic driven samplers were installed at necessary points by the Utah Copper Company and a portion of the mill building set aside as a sampling department where all samples were delivered and handled according to the best practice. The assay office erected by the Boston Consolidated is still in use and so far has not been changed except for the addition of some new equipment consisting of an oil assay furnace, Braun Electrolite Outfit, electric drying oven and a steam water still.

Power

The Boston Consolidated obtained their power from the Telluride Power Company, as did the Arthur Plant also until 1913 when the power company was absorbed by the Utah Power and Light Co. Initial electrical equipment consisted of 3000 KW, taken at 44 Kv and transformed to 440 volts for distribution in mill and shops. In 1913 this capacity was increased to 4500 KW to meet requirements of roll installation and increased tonnage. In 1915 these transformers were abandoned, thru obsolesence, and were replaced with modern transformers of 6,000 KW capacity. In 1916 a second bank of 6,000 KW capacity was installed making a total of 12,000 KW. Complete new primary and secondary switch boards were also installed at the time, making all circuits automatic.

In 1917 an additional substation of 9,000 KW Capacity was built to furnish power for flotation plant; this station being practically a duplicate of equipment previously installed.

This brings the available capacity of both stations to 21,000 KW, same being received at 44 KV and delivered to motors at 440 volts.

In 1920, the then existing contract with the Utah Power and Light Company, for delivery of power at 44 KV was annulled and a new contract entered into for delivery of same at 130 KV. This necessitated construction of an out-door station and the installation of transformers of 50,000 KVA capacity, at Magna, to transform from 130 KV to 44 KV for distribution to the various plant substations. This equipment was put in service with 25,000 KVA capacity in 1922 and was finally completed with 50,000 KVA capacity early in 1923

Accessory Buildings

The following buildings were either built new entirely, or remodelled to accomodate increased milling capacity

Administration

This building is a two story structure 38 feet 8 inches wide by 145 feet long. It replaced a former office building and was completed in April 1918.

Hospital

The office or administration building formerly used was remodelled and fully equipped as a local hospital. Completed during latter part of 1918.

Garage

Auto trucks were substituted for horses and wagons during the latter part of 1915. To house these auto trucks a garage was built. The building was 24 feet wide, 88 feet long and 12 feet high constructed of corrugated iron and completed early in 1916.

Warehouse

A one story building 120 feet long with basement was constructed in 1910. An extension of 90 feet was finished during 1918.

Time Office

A one story brick structure was finished in January 1923. This building is divided into two departments, time office and employment.

Shop Buildings and Equipment

Rigger Shed

The original building was 52 feet 8-1/2 inches wide, 80 feet long and 26 feet high. Steel frame, covered with corrugated iron. Completed in 1913. In 1917 and 1918 an extension of 131 feet length by 47 feet in height was made. Part of this extension furnished quarters for Tin shop, Electrical repair shop and also pipe fitting shop. A second extension of 112 feet was completed during 1922. New equipment consists of the following:

Pipe Shop:- Landis pipe machine installed 1917

Tin Shop:- Circle Shear installed 1923
J M Robinson 8 ft brake installed 1923

Electric Shop:- Emery Wheel installed 1923
2 Segeir Coil forming machines installed 1923
Segier Taping Machine installed 1923

Machine Shop

Original building was a wood structure, with concrete to bottom of windows; 42 feet 2 inches wide, 176 feet long and 22 feet high. In 1916 an extension of 32 feet on West end was made and a second extension of 112 feet on East end was completed in 1917. An office building 19 feet by 33 feet was added in 1911 and a tool room 29 feet by 47 feet in 1915. New equipment consists of the following:

1 Drill Press	Installed	1917
1 Automatic Saw Grinding Machine	"	1917
1 Automatic Screen Cutting Lathe	"	1917
1 Le Blonde Lathe 21 inch	"	1917
1 American Lathe 24 inch	"	1917
1 Hurtness Flat Turret Lathe	"	1917
1 Keyseater No 5	"	1917
1 Boring Mill 60 inch	"	1917
1 Radial Drill 6 feet	"	1917
1 American Lathe 48 inch	"	1917
3 Emery Wheels	"	1917
1 Shaw Crane 10 tons capacity	"	1918
1 Vertical Turrett Lathe	"	1920
1 Press 500 ton	"	1922
1 Punch and Shear Machine	"	1923

Boiler Shop

This building consists of an extension to the warehouse building 120 feet long, which was completed in 1916. It

is 50 feet wide and 25 feet 6 inches high. New equipment consists of the following:-

1 Air Hammer 2200 pounds	Installed	1917
Pressure Clamps	"	1917
3 Carbic Generators Model B-2	"	1920
1 Bolt Machine 3 headed	"	1920
1 Radial Drill Press (From Machine Shop)	"	1920
1 Electric Rivet Heater Size 32	"	1917
1 " " " Size 33	"	1917
1 Ryerson Frittion Saw	"	1917
1 Punch and Shear No. 3-1/2	"	1917
Plate Bending Rolls #3	"	1917
1 Emery Wheel	"	1917
1 Oxy-Acetylene Welding Set-	"	1920
1 Arc Welding Set	"	1920

Carpenter Shop

This building is a steel frame structure, 60 feet wide, 120 feet long and 16 feet high, covered with corrugated sheet iron. It was completed in 1913. New equipment consists of the following:-

1 Band Saw No. 146	Installed	1917
1 Planer 8'foot by 24 inches	"	1917

Foundry

Originally this building was 20 feet wide, 120 feet long and 14 feet 3 inches high. Steel frame with corrugated iron covering. It was built in 1910 but in 1912 an extension of 15 feet was made on the west and 60 feet on the east end. In 1915 the crane-way was extended east 25 feet 6 inches and also an extension of 30 feet made to the building. Storage bins for coke, sand, etc., were also constructed. A cleaner shed was added in 1914. In 1916 a further extension of 90 feet was made on the east end and in 1917 the charge floor was increased. New equipment was added as follows:

1915

1	Osborne Core Jolt Machine
1	Osborne Baby Jolt Machine
1	Rod Cutter
1	Tyler Recording Thermometer
1	#2 Stand Batch Mixer
1	15 ton Neles Crane
1	Plain Jar Ramming Machine #100
1	" " " " #101
1	Western El. Cent. Compressor
2	Blast Meters
1	Air Squeezer and Jolt Machine

1	6 ton Pet Scale
1	Gyratory Riddle
1	Skull Crusher

1916

3	Buckeye Oil Heaters
1	2 ton Niles Crane
8	Osborne Stripping Plate Machines
1	Herman Jar Moulding Machine
2	Stripping Plate Machines
1	G.E. Centrifugal Compressor
1	W.E. Centrifugal Compressor
1	Sand Blast Machine
2	Platform Scales
1	15 ton Whiting Crane

1917

1	Small Core Saw
1	Rod Cutter
1	Peerless 4000# Hoist
1	2 ton Triplex Block
1	1 " " "
1	Electric Magnet for Hoist
2	Osborne Air Squeezer & Jolt Machines
1	2 ton Whiting Hand Crane
1	1 " " " "
1	#7 Whiting Cupola
6	Blast Gates
1	Air Hoist (Whiting)

1918

3	Worthing Air Riddles
1	Link Belt Locomotive Crane
1	Electric controlled Lifting Magnet

Brass Foundry

This building was erected by the Boston Consolidated and has not been increased in size by the present company. New equipment consists of the following:-

1	Swartz Furnace 42 inch	Installed	1917
1	Worthington Rod Straightener	"	1917
4	Crucibles	"	1917
1	Duples Hoist 1-1/2 Tons Capacity	"	1917
1	Emery Wheel	"	1918

Pattern Storage

This building is of wood frame covered by corrugated sheet iron. It is 64 feet wide, 126 feet long and 36 feet high, and was completed in 1917. Equipment consists of one Sprague electric hoist for handling patterns from various floors.

Grinnel Sprinkling System

Installed during 1916 and 17 to protect Pattern Storage, Lumber Sheds, Carpenter Shop and Warehouse.

Industrial Tracks

These tracks were placed for shop and rigger transportation facilities and were put in operation during 1920. There are 2 storage battery locomotives in this service.

Heating Plant

The original heating plant consisted of two Heine boilers of 420 H.P. each. In 1919 a new heating plant building was started and finally completed in 1922. This building is 84 feet by 36feet, steel frame, and covered with galvanized iron. Two Heine boilers having a capacity of 420 H.P. each were brought over from the Magna Power Plant and installed in 1919. In 1922 both boilers were transferred from the old plant. Taylor stokers were also installed and an elevator placed to hoist coal from railroad track bin to stokers.

E. A. Taylor
Metallurgical Engineer

Arthur Plant
Oct. 19, 1923

UTAH COPPER COMPANY

HISTORY OF THE MAGNA PLANT

The Magna Plant is located on a 3000 acre site, [illegible] miles west of the Garfield Smelter and 17 miles west of Salt Lake City. The building, 505' x 600' is of steel frame, corrugated iron siding, concrete foundation and composition roofing. The mill building and outlying buildings occupy a 20 acre tract. The first ore was milled at the Magna Plant in June 1907, and the entire plant was completed and put into operation in November 1908. From 1909 to the present date many changes were made in equipment, and it is the purpose of this record to detail and give the reason for any extensive change made in method or equipment. The mill proper will be taken up by departments: Coarse Crushing, Fine Crushing, Concentrating etc., but the general changes outside the mill itself will first be discussed.

The ore was first transported from the mine at Bingham to the mill by the Denver & Rio Grande Railroad, but in October 1911 the Bingham & Garfield Railroad, a subsidiary of the Utah Copper Co., was completed and thereafter most of the ore was handled by the Bingham & Garfield Railroad. Part was still handled by the Denver & Rio Grande, however, until the mill closed down in February 1919. After resuming operations in November 1922, all the ore was hauled by the Bingham & Garfield Railroad. The cars used are steel, of the [illegible] bottom type holding a load of about 70 tons each. When the car dumper is completed the cars will be changed over to a flat solid bottom car capable of hauling about 80 wet tons.

Electric power for the mill was originally furnished by a steam electric power plant of 13,000 horse-power located [illegible] feet north-east of the mill, but this plant was shut down in February 1919 when the company contracted for hydro-electric power with the Utah Power & Light Co. The power plant equipment was as follows: [illegible] Heine 419 horse-power water tube boilers equipped with American automatic stokers and separate mechanical drives, two 26 x 50 x 48" Allis Chalmers cross-compound Corliss condensing engines direct connected to two 1500 kilowatt A. C. generators, and three 32 x 70 x 48" Nordberg cross-compound Corliss engines direct connected to three 2250 kilowatt A. C. generators. The building is 138' x 288' of steel and brick frame with two concrete smokestacks 180' high and 18' in diameter at the base. In 1923 three or four of the boilers are being used to supply the Magna plant with steam, the other equipment having been sold or left in place.

Water for the mill was originally obtained from artesian [illegible] located near the power house, and also from a drainage pond north-east of the power plant. The water was pumped from the pond into a canal which carried the water to the power house, from whence it was pumped through a 30" wood stave pipe to a 5,500,000 gallon concrete reservoir above the mill. Part of the tailing water was recovered and returned to the mill pond. The original pumping equipment at the power plant, or pump house #1, was three 3-stage D'Olier centrifugal pumps of 2500, 3000 and 4500 gallons per minute capacity. At the present time [illegible]

three 3-stage Jeansville centrifugal pumps of the same capacities, three Byron Jackson pumps 10,000 gallon capacity each, and one Byron Jackson 5,000 gallon pumps. A 10,000 Nordberg triple-expansion condensing pump which was in use in 1916 and 1917 has since been [illegible]. This supply of water became inadequate and in 1911 the company purchased an interest in the Utah and Salt Lake Canal, a canal company operating for irrigating purposes, and drawing water from Utah Lake thirty-five miles south of the plant. The canal was enlarged and extended to the plant, and enough water was developed from this source to supply both the Magna and Arthur plants, leaving [illegible] as an auxiliary supply. The canal discharges into #2 pump house, built in 1911, and from there is pumped to the Magna & Arthur [illegible] through 30" and 42" stave pipe. Much trouble was experienced keeping the canal open, especially during the flood seasons and in the winter months. To eliminate some of this trouble the canal was concreted, bottom and sides, for a distance of three-fourths of a mile during the period from 1913 to 1917. In addition an ice conveyor, or [illegible] steel conveyor was installed in the canal near the #2 pump house in 1919 to remove blocks of ice, slush, and moss from the water before it reached the pump house. The equipment of #2 pump house is as follows: two single-stage 10,000 gallon Worthington centrifugal pumps, and one single-stage 5,000 gallon Worthington centrifugal pump for lifting water to the Magna reservoir through 7300' of 42" wood stave pipe. Three 5,000 gallon Worthington pumps and one 5,000 gallon Byron Jackson pump send the water to Arthur through 6,300' of 30" and [illegible] wood stave pipe.

The mill was, and still is, divided into two equal units, unit 1 on the East end and unit 2 on the West. The coarse crushing department is subdivided into four sections, 1 and 2 on unit 1, and 3 and 4 on unit 2. The fine crushing and concentrating departments are subdivided into 12 sections, unit 1 embracing sections 1 to 6 and unit 2 sections 7 to 12. The mill was built to handle 6,000 tons of ore per day, and gradually increased to 24,000.

COARSE CRUSHING DEPARTMENT

This department as originally built included a 25,000 ton coarse ore bin, with three standard gauge [illegible] railroad tracks at the top where the 50 ton steel ore cars were dumped. The coarse ore was then transported from the coarse bins in electric [illegible] cars to 4 #7-1/2 Gates gyratory crushers after it was screened over 2-1/2" [illegible] iron grizzlies. In this department there were 4 - 24" [illegible] conveyors, 4 - 36" bucket elevators, 60' [illegible], 8 trommel screens, [illegible] samplers; 4 - 54 x 20" Garfield rolls, and 52 [illegible]. In 1909 the trommel screens were replaced by 8 [illegible], the trommels having held up the operation. In 1911 [illegible] screens of 5/8" steel wire were placed in [illegible] track and 24 steel apron feeders 2'-6" x 5' were installed [illegible] undersize to 4 - 18" belt conveyors. Four 24" belt conveyors delivered the undersize direct to the fine bins. In 1916 [illegible] grizzly bars with 2-1/4" opening were installed in the [illegible] and 14" opening grizzlies on the [illegible] floor [illegible]. Rock over 14" in size was then broken by [illegible] eliminated all except the [illegible]. [illegible] conveyors with 107' centers replaced the 24" conveyors to the fine ore bins and 4 - 36" conveyors with 178' centers replaced [illegible]

conveyors. Four 36" conveyors with 75' centers handled the 54 X 20" roll product, since the 36" elevator as former discharged into the fine bins. The basket ore gates were replaced with 80 apron style feeders, and 6 - 30" conveyors, while 4 - 48" pan conveyors and 60 apron style feeders handled the material. Two steel [illegible] hoppers were built and a double swing [illegible] sampler replaced the 4 [illegible]. The addition of the 4 - 36" conveyors 170' long necessitated building a lean-to addition along the south wall of the mill building. Four more 54 X 20" rolls were installed in 1914 and 60 more apron feeders and 6 more 30" conveyors were added to the undersize part of the bins. At this time 2 - 15 ton Niles cranes were installed to serve the two coarse crushing units. In 1918 the work of remodeling the west half or unit 2 of the secondary coarse crushing plant was started. A system of 12 conveyors replaced the 4 elevators. There are 4 - 48" conveyors, 4 - 36", and 4 - 30". Four sets of 72 X 20" Garfield rolls were added to the four sets of 54 X 20" rolls already in use. Four steel screening towers, with automatic roller feeders were built. In the four towers there are 16 - 4' Alaska impact screens. The two #7-1/2 [illegible] gyratory crushers were left in place for temporary use. Four stationary screens were added below the 54" rolls. This plant is designed to do all the secondary crushing with a mill capacity of 24,000 tons per day, and therefore, when the primary crushing plant, described later, is finished, the coarse ore bins, with feeders, conveyors, all four #7-1/2 crushers and the entire equipment of unit 1 secondary crushing plant will become obsolete, or will be held for emergency equipment.

In April 1923 work was started on a new primary coarse crushing plant. This new installation will include 1 Wellman-Seaver-Morgan electric car dumper which handles 2 cars at once and will dump a maximum of 720 cars or about 48,000 dry tons of ore per day; 1 #27 Allis Chalmers gyratory crusher, capable of taking 54" material and reducing it to 4-1/2"; one set of 5-1/2" grizzlies ahead of the #27 crusher; 2 - 54" X 39' conveyors handling the feed to the #8 crushers; 4 - 6' Jeffery feeders below the #27 crusher; 4 - #8 Allis Chalmers gyratory crushers; one set of 2" grizzlies ahead of the #8 crushers; 2 - 54" X 667' conveyors running through a 9' X 24' X 820' concrete tunnel to the secondary crushing plant and a set of impact screens at the discharge end of these conveyors. A Merrick automatic weighing device is to be installed on the two 54" conveyors in the tunnel. There will be two electric cranes, one 50 ton and one 30 ton. It is expected that this plant will be entirely finished late in 1923.

FINE CRUSHING DEPARTMENT

This department as originally built had 12 - [illegible] dry elevators; 12 - 24" wet elevators; 24 sets of 37-1/2 X 15" Garfield rolls; 48 trommel screens to handle roll product; a 12,000 ton steel bin with 24 plunger type feeders; 36 - 6' Chilean mills; 12 - 200 horse-power motors and a 15 ton Northern Electric crane. In 1911 the plunger type feeders were removed and 24 steel apron feeders 2'6" X 5' were installed. In 1917 these 24 feeders were replaced by 12 - 54" steel apron feeders. The 200 horse-power motors were changed to 300 horse-power in 1911 and in 1917 they were again changed to 450 horse-power. In 1911 the trommel screens were replaced by 48 - 3' X 4' Colorado impact screens in order to increase tonnage. In 1915 24 more Colorado impact screens

were added, making a total of 72. In July 1917 the work of installing tube mills was started. This change was made necessary partly by the prospective use of flotation, which required much finer grinding than necessary heretofore, and partly to lower the tailings on gravity concentration. Two electric cranes were installed; one 50 ton E. and H. and one 15 ton E. and H. A total of 36 - 7' X 10' pebble tube mills was installed; 24 eight foot Mitchell type primary drag classifiers; 36 - 6 foot Mitchell type secondary drag classifiers and 12 more 36" wet elevators, while the 24" wet elevators there commenced in this work not being entirely finished until 1923. In 1923 the 8' classifiers were moved under the six-foot machines, and 12 more were In 1922 a few Dorr bowl drag classifiers - type G were installed, taken out on account of unsatisfactory service, and replaced by the 36 - 8' drags. In June 1923 the work of adding 36 more 3' x 4' Colorado impact screens was begun, and the changing of all 24 rolls to 42" X 24" size. All 12 of the 24" dry elevators will be changed to 30" as the work progresses. These changes, together with the coarse crushing department changes are made partly to increase the mill tonnage and partly to get the finer grinding necessary for flotation with consequent better extraction. The Chilean mills were not used after the mill closed down in 1919; they are partly dismantled in 1923. During 1923 all the tube mills were loaded with steel balls instead of rock and this necessitated changing the motors from 75 horse-power to 150 horse-power. This increased the tonnage and made better grinding, since the steel mills grind more than the pebble mills.

GRAVITY CONCENTRATING DEPARTMENT

This department as originally built had 24 Iron Traylor Range compartment classifiers; 72 Traylor jigs; 48 - 5 Wilfley finishing tables; 576 - 12 X 6' Johnston slime vanners, 528 - 10 X 6' Corrugated Johnston sand vanners; 12 - 6" slime pumps; 240 - 5' 60 degree conical settling tanks; 144 - 7' 60 degree conical settling tanks with auxiliary motors; line shafts, belting etc.

In 1910, the Traylor jigs having proven unsatisfactory from a metallurgical viewpoint, 72 Garfield roughing tables were installed in place of the jigs. At the same time, the Traylor classifiers were abandoned and in their place 48 Richards-Janney 4 spigot intermittent classifiers were installed. The extraction shows an increase after this change. In 1911 24 additional Richards-Janney 5 spigot classifiers were installed as secondary classifiers on the north side of the first vanner floor, and 24 more 5 Wilfley finishing tables. At this time return pumps were put in on the second vanner floor to return coarse tank overflow. This was partly on account of water shortage and partly in an attempt to recover fine mineral floating over the sand vanners. In 1911 to 1912 a retreatment plant was installed on the 3rd. vanner floor to handle vanner low grade concentrate. This occupied four sections, and for this purpose 4 Richards-Janney 4 spigot classifiers and 8 Wilfley tables were added, while 12 Johnston vanners which were already in use were changed over to retreatment work. The idea of this change was to produce a better grade of concentrate for shipment to the smelter. This plant did bring about a marked lowering of the insoluble material in the concentrate. From September 1911 on, the iron in the concentrate invariably exceeded the silica which before had been a smelter penalty had to be paid on excess silica.

In April 1922 the work of dismantling the gravity concentrate department was begun. By November 1922, all gravity concentrating equipment except 144 Garfield roughing tables and 48 Wilfley finishing tables was dismantled. These tables are still in use ahead of flotation.

FLOTATION CONCENTRATING DEPARTMENT

The first flotation machines were put into operation at the Magna plant in August 1914 on the third floor of section 6. They were Janney machines of the straight mechanical type. This experimental plant first handled the overflow from the hydraulic classifiers in the four retreatment plants, this being thickened in a 44' Dorr tank. Shortly afterward another experimental machine was put into operation on the same section to handle slime feed. This machine was converted to retreatment and in November 1918 a Janney Magna type mechanical-air machine of 9 rougher and two cleaner cells was installed on section 1 to treat slime feed. A 20' Dorr tank thickened the feed for this machine. The 44' Dorr tank was torn out in 1922, as were the experimental flotation machines. Preliminary to the installation of a slime flotation plant, construction work was started during 1918 on a 225 ft. concrete thickening tank which remained unfinished when the plant shut down in February 1919 due to unfavorable market conditions for copper. When the plant was down, plans were made for installing a flotation process which did not require thickners, consequently this concrete tank still remains unfinished and will probably never be used. The present flotation plant is located on the old second vanner floor, and partly into the first, the gravity concentrating equipment on this floor, except 48 Wilfley tables having been torn out. There are 48 rows or 8 sections of the Magna type Janney mechanical-air machines on sections 3, 4, 5, 6, 7, 8, 9 and 10. Each row consists of one emulsifier, eight rougher cells, two cleaner and one recleaner cell. They were modeled after the same type machine used as an experimental plant at Arthur, but after being in operation for sometime it was found that the machine was not capable of taking the tonnage nor giving the recovery it should. This was remedied by changing the circulating and feed pipes. There are 576 motors on the flotation cells, 6 Roots #8 blowers, 2 37,000 gallon steel tanks for sulphuric acid, 2 14,000 gallon steel tanks for flotation oil, 4 auxiliary 800 gallon steel tanks for acid distribution, 2 variable speed acid feeders, 12 pulley and pan type oil feeders with a pump for circulating the oil through the pipe system. Six 2 ton Sprague electric cranes serve the flotation machines. There are 12 Wilfley slime pumps and two concrete sumps for cleaner tailing. This plant is practically complete in October 1923. To carry the extra load a new 7500 K. V. A. substation was built at the west end of the flotation plant.

CONCENTRATE DEWATERING DEPARTMENT

The original method of handling table or vanner concentrate was to settle and dewater in 16 concrete bins, from which it was loaded into filter bottom concentrate cars by a 3-1/2 ton Gantry crane, and then shipped to the Garfield smelter. The introduction of flotation and finer grinding made it necessary to install thickeners and filters, since simple decantation would not give a dry enough product to handle, and losses would be high. During 1917 and 1918 two 14' x 22' Portland filters were installed; two 75' Dorr thickeners; a 36" elevator for filter feed; two Gardner-Rix vacuum pumps, and conveyor belt for loading

filter product into cars. In 1923 six more 75' Dorr thickeners were installed; eleven 14-1/2' - 4 leaf American filters; two sets of 2 spigot Richards-Janney classifiers to handle Wilfley concentrate; four 6' Witchel type drag classifiers, used as dewaterers; two 27 x 14" Ingersoll-Rand vacuum pumps; two 36 x 20" Ingersoll-Rand vacuum pumps; and four automatic electric concentrate samplers. There are two 20" conveyors 200 and 300' long; 2 - 30" conveyors 200 and 300' long, and two 18" twin bucket elevatos. The Portland filters, vacuum pumps and equipment were dismantled in July 1923. The 3-1/2 ton Gantry crane will be obsolete when all changes under-way are completed, and the concentrate bins will be used only for additional settling space for Dorr tank overflow.

SUMMARY

When changes under-way in 1923 are completed the original coarse crushing plant will have been almost entirely replaced, except for 4 sets of 54" x 20" rolls; the bins, crushers etc. all being obsolete. The fine crushing machinery will all have been changed from the original installation, the bins only remaining. In the gravity concentrate department none of the original installation will be left, except some of the tables. 144 Garfield rougher tables and 48 Wilfley finishing tables will still be in use, but the Garfield tables were added in 1910. The flotation department entire is a 1923 addition, and the concentrate dewatering plant is also entirely changed, except for the original 16 concentrate bins. For making these changes there were only two major reasons, to increase tonnage or to improve the metallurgy. Increased tonnage caused nearly all changes in the crushing departments, while in the concentration departments the principal changes were made to improve the recovery. It was very rarely that the equipment as installed failed to do the work expected of it at the time. The tonnage per day has gradually increased from the 6000 planned on in 1907 to possibly 24,000 in 1924, while the percent extraction has increased from 65 to 80.

SHOPS AND BUILDINGS

Accessory Buildings

The main office is a two-story brick building 50' x 50' built in 1907. In it is the emergency hospital, Magna club rooms, and offices for the superintendent, assistant superintendent, field engineer and matallurgical department.

The dormitory is a frame building 94'6" x 34'2" containing 13 rooms, built in 1907.

The mess house is a two-story frame building 41'10" x 30'10" also built in 1907.

The superintendent's residence, a six room brick cottage, was built in 1918, while ten more five and six room brick cottages were built in 1920. There are two frame residences east of the plant, and seven more four room brick cottages are being built in 1923. For the cottages there are 3 - four stall brick garages.

The company owns 8 frame buildings used for Japanese, Greek and other foreign labor quarters, built in 1912.

The time office is a frame building just west of the main office, and is equipped with time clocks and a small amount of office furniture.

There was a [illegible] building, [illegible] office. [illegible] [illegible] all [illegible] work [illegible].

The [illegible] department [illegible] to the mill yard, [illegible] north-east corner of the mill building.

[illegible] Shop

[illegible] 1914.

[illegible] x 44'5", steel and corrugated [illegible] roofing, [illegible].

Machine Shop

Original size 152'10" x 58'9", steel frame, [illegible] sheathing and composition roofing. [illegible] 30' west and 28' east (tin shop) [illegible]. Office [illegible] tool room 30' x 18'6" and [illegible] room [illegible] present length 255'.

Machine Shop Equipment

5 ton Whiting crane	[illegible]
1910 - 24" L. & S. lathe	1906 - 24" Bradford lathe
1906 - 18" Hendy shaper	1917 - [illegible] universal [illegible]
1906 - 5' Bickford drill press	1906 - [illegible] L. & S. [illegible]
1906 - 10' planer	1917 - 24" L. & S. [illegible] lathe
1906 - 24" Aurora drill press	1916 - [illegible]
1906 - 20" L. & S. Sup. lathe	1906 - [illegible]
1906 - 42" Fifield Sup. lathe	1910 - [illegible] bolt [illegible]
1906 - #2 Universal milling machine	1910 - [illegible]
1910 - 72" Chambersburg 500 ton wheel press	1912 - [illegible]
	1910 - [illegible]
1911 - 26" Niles slotter	1911 - [illegible]
1923 - 10' boring mill	1914 - [illegible]
1918 - 48" L. & S. lathe	1923 - [illegible]
1918 - milling machine	1918 - [illegible] L. & S. lathe
1917 - 5 H. P. emery grinder	1919 - 15" [illegible] lathe
1906 - 14" Bradford lathe	1919 - universal grinder
1906 - power hack saw	1915 - [illegible] shaper
1915 - [illegible] worm cutter	

Tin Shop Equipment

19[illegible] - 8' double geared hand power brake	Combined folder and [illegible]
30" square shears	30" former
36" former	Stove pipe folder
Small burring machine	

Boiler Shop

Originally built as warehouse 1906, 105' x 90' x 90' x 15' steel frame, corrugated sides and roof. Extension south side [illegible] x 16" - 1917.

Boiler Shop Equipment

1911 -	1700# Sellers steam hammer	1910 -	2" Acme bolt header
1910 -	26" Barnes drill press	1914 -	Gertsch plate bending rolls
1910 -	power hack saw	1910 -	20" Champion drill press
1910 -	#3 Hilles & Jones punch and shear	1910 -	#3 Hilles & Jones shear
1913 -	Buffalo blower	1906 -	#4 [illegible] punch & [illegible]
1913 -	small bending rolls	1906 -	800# Monighan steam hammer
1913 -	screen machine	1913 -	power emery grinder
		1913 -	Acetylene welding outfit
		1913 -	two cranes

Carpenter Shop

Steel frame, sheathing and corrugated sides, sheathing and Ruberoid roofing, 153' x 54', built 1917. A refuse disposal plant burns shavings and sawdust.

Carpenter Shop Equipment

1917 -	10# Universal wood trimmer	1911 -	small Universal wood trimmer
1910 -	#2354 band saw	1911 -	#275 [illegible] planer
1906 -	36" band saw	1906 -	[illegible] table saw
1906 -	F. & P. boring machine	1906 -	jointer
1910 -	emery grinder	1906 -	[illegible] emery machine
1912 -	[illegible] swing saw	1916 -	[illegible] rip & [illegible]
1907 -	36" x 5" grindstone	1913 -	home made table saw
	1 electric locomotive		2 lumber cars

Warehouse

Steel and corrugated sides and roof, 155' x 50', built in 1910. Extended 15' east and 30' west in 1917.

Lumber Shed

Wood frame, corrugated roof and sides, 240' x 60', built in 1917.

Garage

Wood frame, corrugated roof and sides, 60' x 24', built in 1916.

Grinnel Sprinkling System

One 75,000 gallon steel tank 20' x 30', with [illegible] pipe to carpenter shop, warehouse and lumber shed.

Gravel Plant

Crushers, screens, drag line etc., for furnishing gravel and sand for construction jobs.

Electric Shop
Enclosure made in east end of [illegible] 1923, with office, wash-rooms etc.

Electric Shop Equipment

One second-hand drill press, one emery wheel and one second-hand lathe for winding coils.

Sub-Stations
The initial capacity of the electrical installation of the Magna plant was 5500 K. W. The power was at that time generated by steam at 4000 volts and transformed to 440 volts for distribution to mill motors.

In 1914, the original 4000 to 440 volt station was [illegible] and a new substation was installed to receive power at 44000 volts and distribute it to mill motors at 440 volts. The transformer capacity of this station was 9375 K. W., which was increased, in 1916, to present capacity of 18750 K. W.

In 1917, a substation for 44000 to 440 volt transformation with a capacity of 750 K. W. was installed at the [illegible] plant. This station was abandoned in 1923.

In 1923, an additional substation, known as Magna No. 2 was built to receive power at 44000 volts and distribute it to flotation and dewatering departments at 440 volts. The capacity of this substation is 9375 K. W.

The total transformer capacity of the two Magna substations is now 28125 K. W.

In 1930, the then existing contract with the Utah Power & Light Company, for delivery of power at 44000 volts, was cancelled and a new contract entered into for delivery of power at 130,000 volts. This necessitated the construction of an outdoor station and the installation of transformers of 50,000 K. V. A. capacity, [illegible] to transform from 130 K. V. to 44 K. V. for distribution to the various plant substations at Magna and Arthur, and to the [illegible]. [illegible] was placed in service with 25,000 K. V. A. capacity in [illegible], and was completed with 50,000 K. V. A. capacity early in [illegible].

Magna Plant
October 13,1923

H. S. Martin
Metallurgical Engineer

UTAH COPPER COMPANY

HISTORY OF THE LEACHING PLANT

The Leaching Plant is situated just South of the Magna Plant, on the hill overlooking the town of Magna. It was built to leach the oxidized ores and capping from the mine at Bingham, the mineral in which could not be saved by gravity or flotation concentration. Construction work was started in September 1916, and in October 1917 the first ore was crushed, but cracks formed in the leaching vats delayed regular operation till January 1918. It was operated until February 1919 and then shut down until May 1920, when operations were resumed. In December 1920 it was again shut down, and has not been operated since. The shutting down of the Leaching Plant was primarily due to the deflation of the copper market, immediately following the war.

CRUSHING DEPARTMENT

The crushing plant was built in two units, each designed to crush 4000 tons to 1/2" in sixteen hours. Only one unit of conveyors and rolls was installed. The equipment was as follows: A steel ore bin of 1880 tons capacity, with 9-3/8" horizontal grizzlies, and 3" 40 degree grizzlies; 2 - 42" conveyors and 16 steel apron feeders on the undersize; 2 - 60" pan conveyors and 16 steel apron feeders on the oversize; 1" x 1" or 1" x 2" wire screens ahead of the crushers and rolls; two #6 Gates gyratory crushers; two sets of 72" x 20" Worthington Garfield rolls; four 42" conveyors and a 30 ton electric crane.

LEACHING DEPARTMENT

In the leaching department there were two 42" conveyors; one loading bridge with automatic tripper for distributing the ore; one electric sampler; twelve mastic lined concrete vats of 4000 tons each capacity, each 100' x 50' x 18', with filter bottoms and a system of drainage launders and fittings underneath; four 37000 gallon steel acid storage tanks; eight Byron Jackson 6" acid proof centrifugal solution pumps; two Byron Jackson 6" centrifugal booster pumps on the fresh water lines; two single stage Ingersoll-Rand compressors; one Nordberg two stage 1000 cubic foot compressor; and five 10" wood stave solution lines extending the full length of the vats, with mastic lined iron valves and fittings at each vat. The mastic lined fittings were not entirely satisfactory and in 1920 a good many of these were replaced by lead lined fittings.

TAILING DEPARTMENT

The tailing department consisted of one Head Morrison unloading bridge with a 125' span, a 10 ton tipper and 40 ton hoppers over the tracks; two steam locomotives of the "dinky" type; four Clark 40 ton dump cars and about a mile of standard gauge railroad track from the leaching vats to the tailing dump. The cars and locomotives were obtained from the mine.

PRECIPITATION DEPARTMENT

In the precipitation department there were twelve 62'6" x 9'6" x 6' mastic lined concrete precipitating launders, four decanting bins 62'6" x 9'4" x 3'4" for dewatering the precipitated copper; twenty-seven wooden auxiliary precipitating launders 60' x 2' x 3'; and a 75' Dorr tank. The launders were insufficient to precipitate the copper completely and in satisfactory form, and in 1918, ten revolving wooden precipitating drums 7'4" x 8' were installed. These were unsatisfactory and expensive to operate, and were replaced in 1920 by three 7' x 10' steel tube mills lined first with 1/2" lead, then 3 inches of wood and inside with cast copper rings. In 1923 these tube mills were taken out, the liners removed, and the mills put into operation as grinding mills at the Magna Plant. When the tube mills were installed, the wooden auxiliary launders were torn out and the concrete launders used as settling tanks for the tube mill discharge. A Bay City steam locomotive crane with a 70' boom and a 43" D. C. electric magnet was used to handle scrap iron. A 62" D. C. electric magnet was purchased in 1920, but was never used.

GENERAL

There was a 750 K. V. A. sub station at the Leaching Plant, where two 150 Kilowatt Westinghouse motor-generator sets produced the direct current used on bridges and cranes.

No permanent buildings, except in the plant itself, were erected at the Leaching Plant. There was an office, store-room tool shed and carpenter shop; all of these frame buildings used first on the construction work.

H. H. Martin
Metallurgical Engineer

Magna Plant
October 15, 1923

UPB